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Reducing detrimental electrostatic effects in Casimir-force measurements and Casimir-force-based microdevices

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Abstract

© 2018 American Physical Society. It is well known that residual electrostatic forces create significant difficulties in precise measurements of the Casimir force and the wide use of Casimir-operated microdevices. We experimentally demonstrate that, with the help of Ar-ion cleaning of the surfaces, it is possible to make electrostatic effects negligibly small compared to the Casimir interaction. Our experimental setup consists of a dynamic atomic force microscope supplemented with an Ar-ion gun and argon reservoir. The residual potential difference between the Au-coated surfaces of a sphere and those of a plate was measured both before and after in situ Ar-ion cleaning. It is shown that this cleaning decreases the magnitude of the residual potential by up to an order of magnitude and makes it almost independent of the separation. The gradient of the Casimir force was measured using ordinary samples subjected to Ar-ion cleaning. The obtained results are shown to be in good agreement both with previous precision measurements using specially selected samples and with theoretical predictions of the Lifshitz theory. The conclusion is made that the suggested method of in situ Ar-ion cleaning is effective in reducing the electrostatic effects and therefore is a great resource for experiments on measuring the Casimir interaction and for Casimir-operated microdevices.

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